



Extending ArFi immersion scanner capability in support of 1xnm production nodes

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Contents

- Lithography requirements & immersion roadmap
- New ArFi technology introduced in HVM
 - Productivity
 - Focus control
 - Imaging
 - Overlay
- Future developments & Summary

TWINSCAN ArFi roadmap supports future nodes

including overlay & focus requirements for multiple patterning



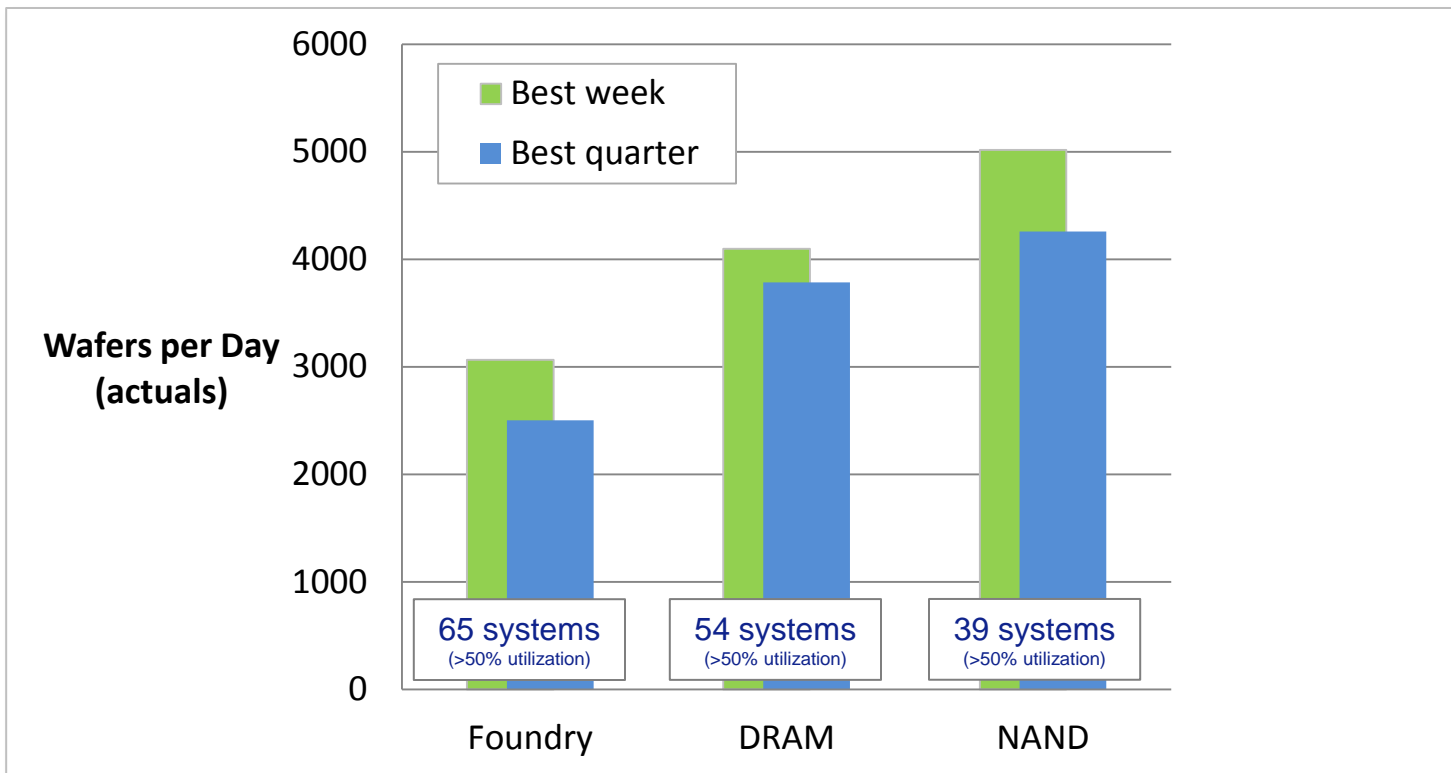
ROADMAP

Litho Requirements	2013 – 2014	2014 – 2015		2016 – 2018
On Product Overlay	6.5 nm	5-3.5 nm	5-3.5 nm	3.5-2.5 nm
CD Uniformity iso	1.8 nm	1.4 nm	1.4 nm	1.1 nm
Total Focus Budget	80 nm	60-55nm	60-55 nm	55-50 nm
	NXT:1960Bi	Node extension package NXT installed base to NXT:1970Ci	NXT:1970Ci	NXT Extensions
Timing	Q1 2013	1H 2014	1H 2014	2H 2015
DCO / MMO	2.5 / 4.5*nm	2.0* / 3.5*nm	2.0* / 3.5*nm	<1.5* / <2.5*nm
Full Wafer Focus Unif	22nm	20nm	20nm	15nm
Full Wafer CDU (iso)	2.0nm	1.3nm	1.3nm	1.0nm
Throughput (96 shots)	230 WpH	250 WpH	250 WpH	250 WpH
Defects/Wafer	10	<7	<7	<7

* Full Wafer to reference

NXT:1960Bi systems show high productivity

Up to > 4000 WpD quarter average, > 5000 WpD best week average





ASML



NXT:1970Ci is in use in HVM

TWINSCAN NXT:1970Ci design improvements

to support down to 10 nm node requirements

Wafer Stage:

*Higher throughput
Tighter focus & overlay
Improved thermal stability*

Lens:

*Reduced non-correctable errors
Improved Matching*

Immersion hood:

Higher productivity

UV Level sensor:

*Process independent leveling
Improved edge focus control*

Parallel lens interferometer:

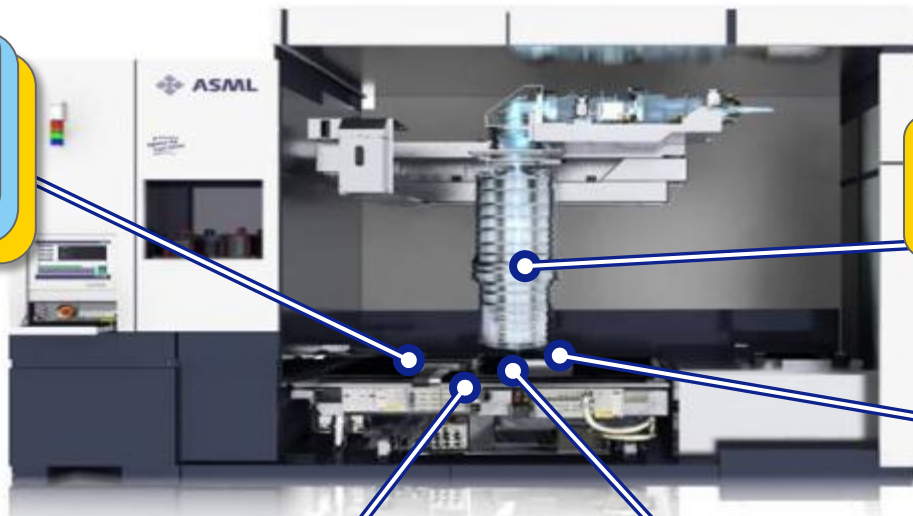
*Improved Lens heating &
Reticle heating control*

Legend:

Overlay

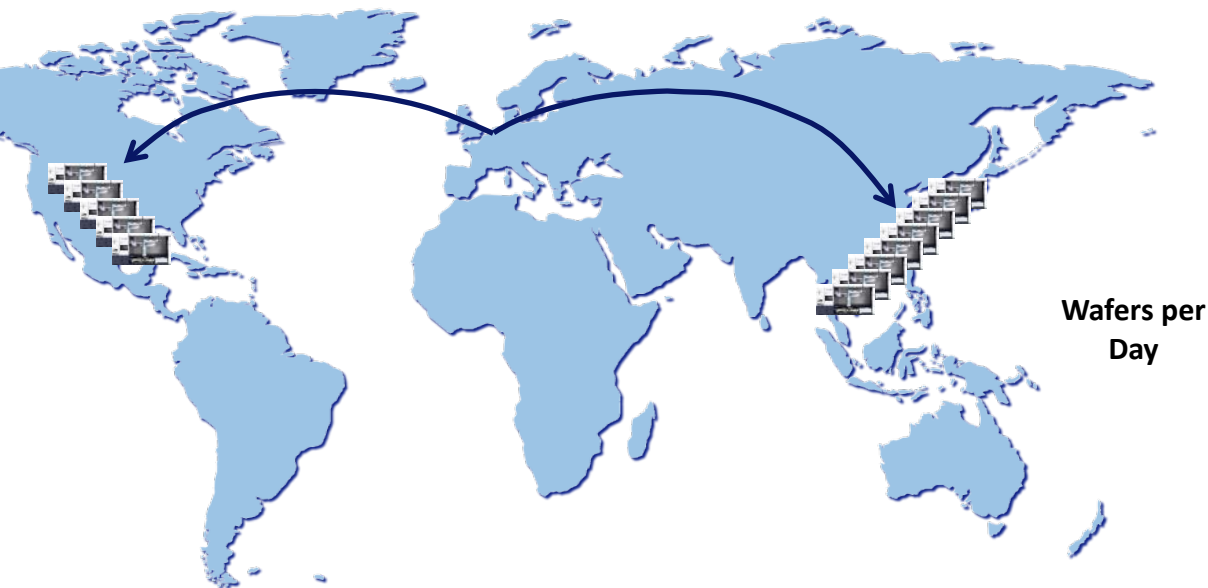
Imaging/Focus

Productivity



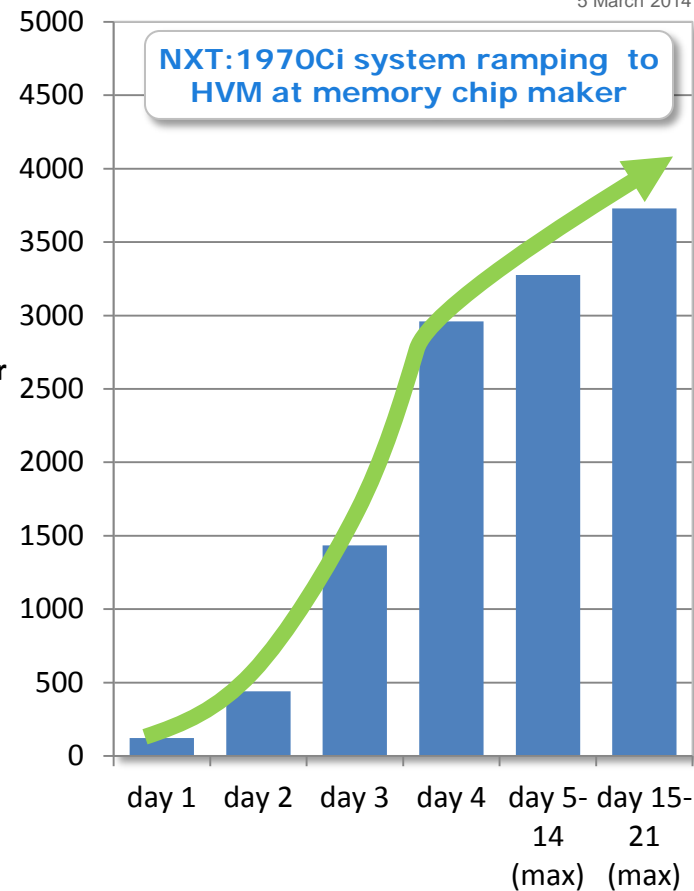
New NXT:1970Ci ramping to HVM productivity in days

in use for Logic, MPU, NAND & DRAM applications



>10 NXT:1970Ci systems in field by Q1 2014

5 systems already in use

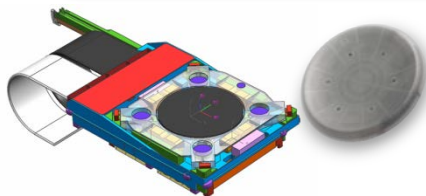


TWINSCAN NXT:1970Ci design improvements

to support down to 1x nm node requirements

Wafer Stage:

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Tighter focus & overlay
Improved thermal stability*



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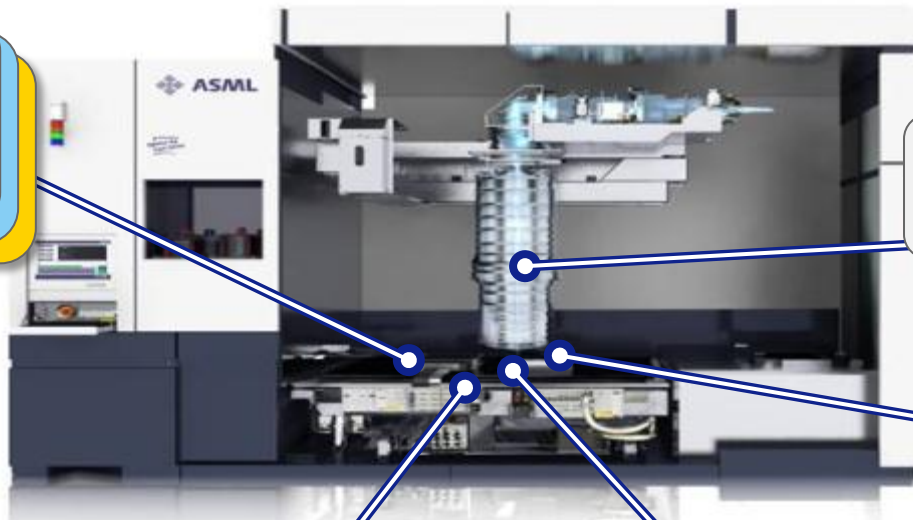
*Improved Lens heating &
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Legend:

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Imaging/Focus

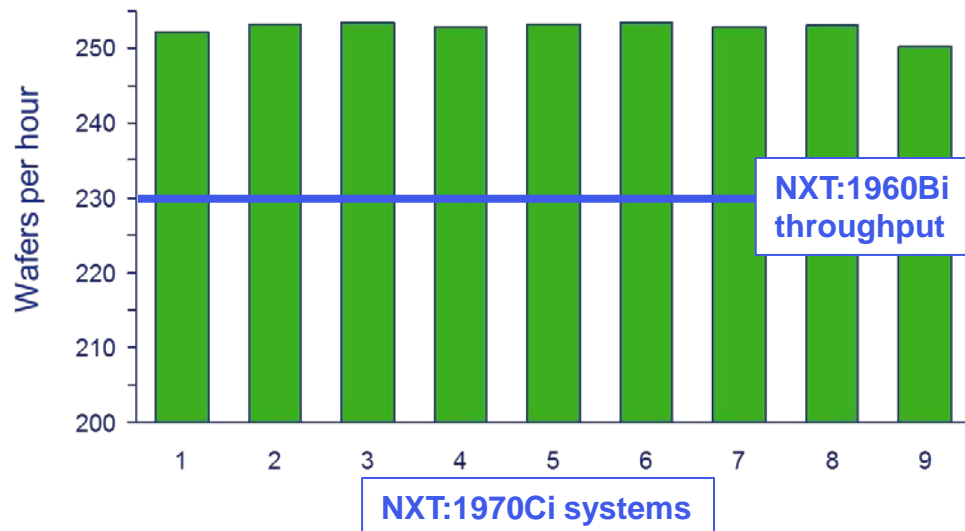
Productivity



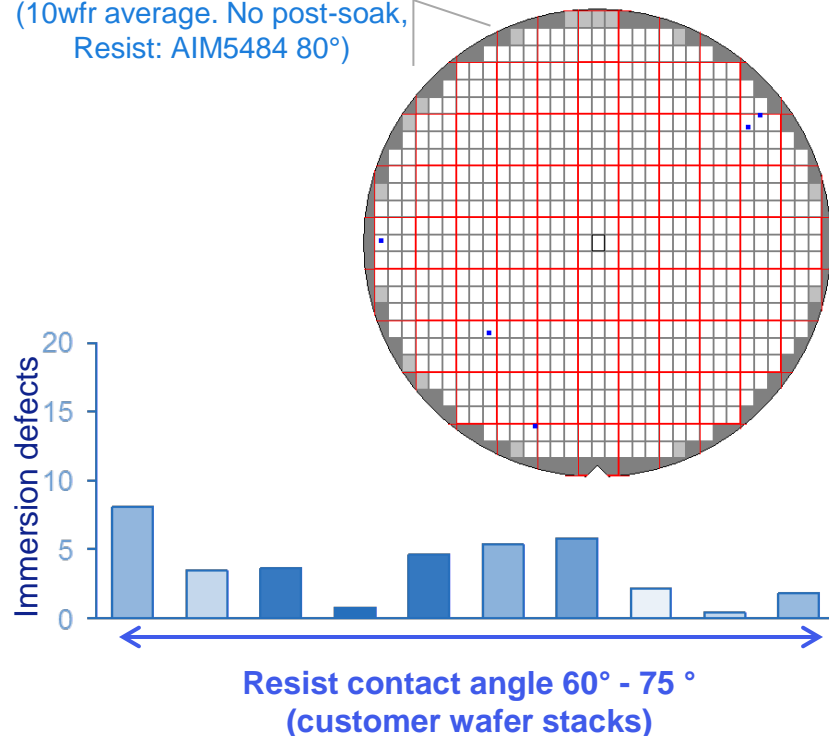
250 WpH NXT:1970Ci wafer throughput proven

with robust immersion defect control

New wafer stage & immersion hood support 800mm/s scan speed



0.6 scanner defects/ wfr
(10wfr average. No post-soak,
Resist: AIM5484 80°)



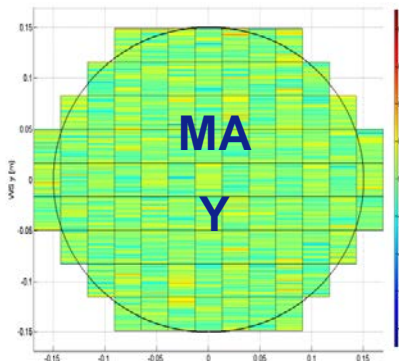
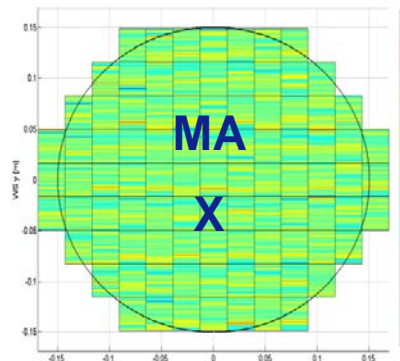
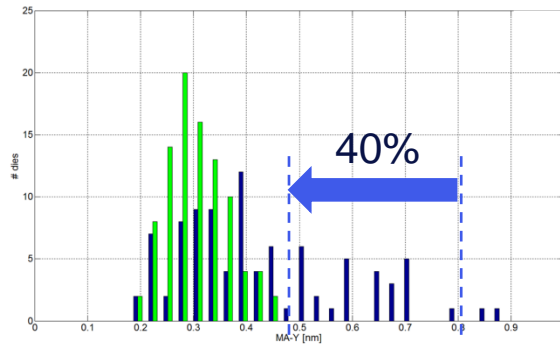
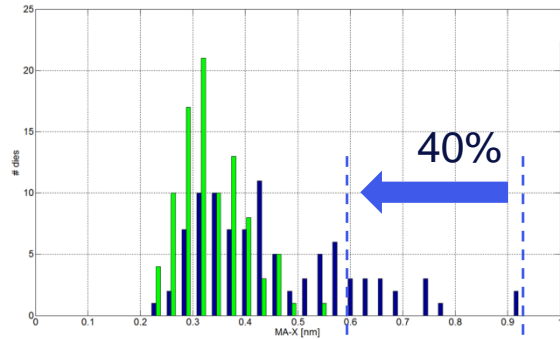
NXT:1970Ci wafer stage improved dynamics

at high productivity with consistent performance from centre-to-edge

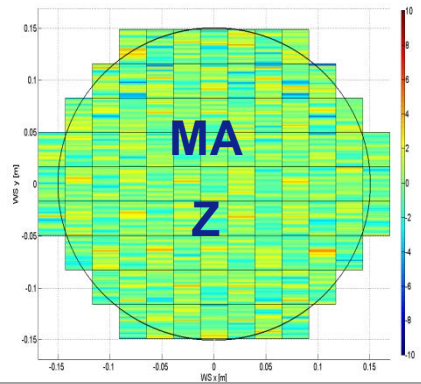
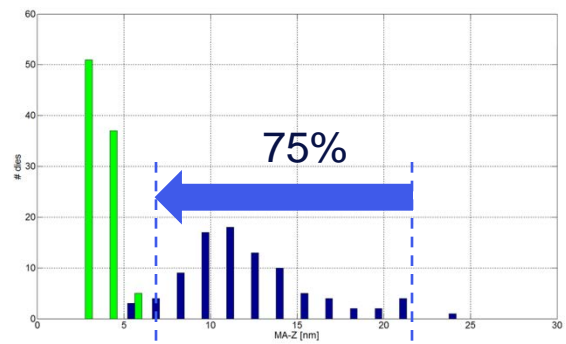
1960Bi 0.7 m/s

Overlay

1970Ci 0.8 m/s

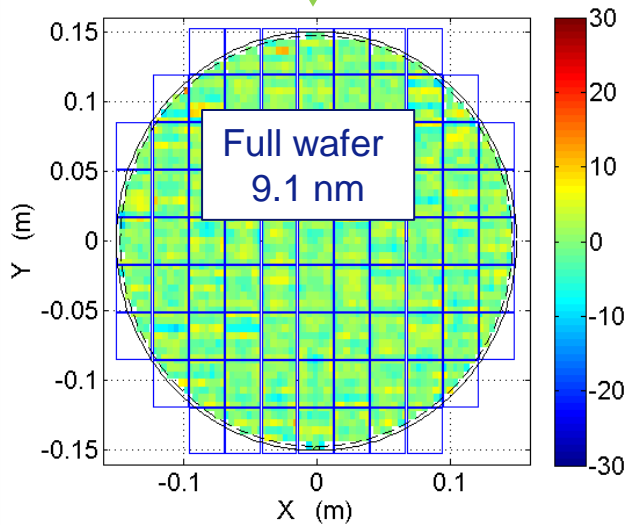
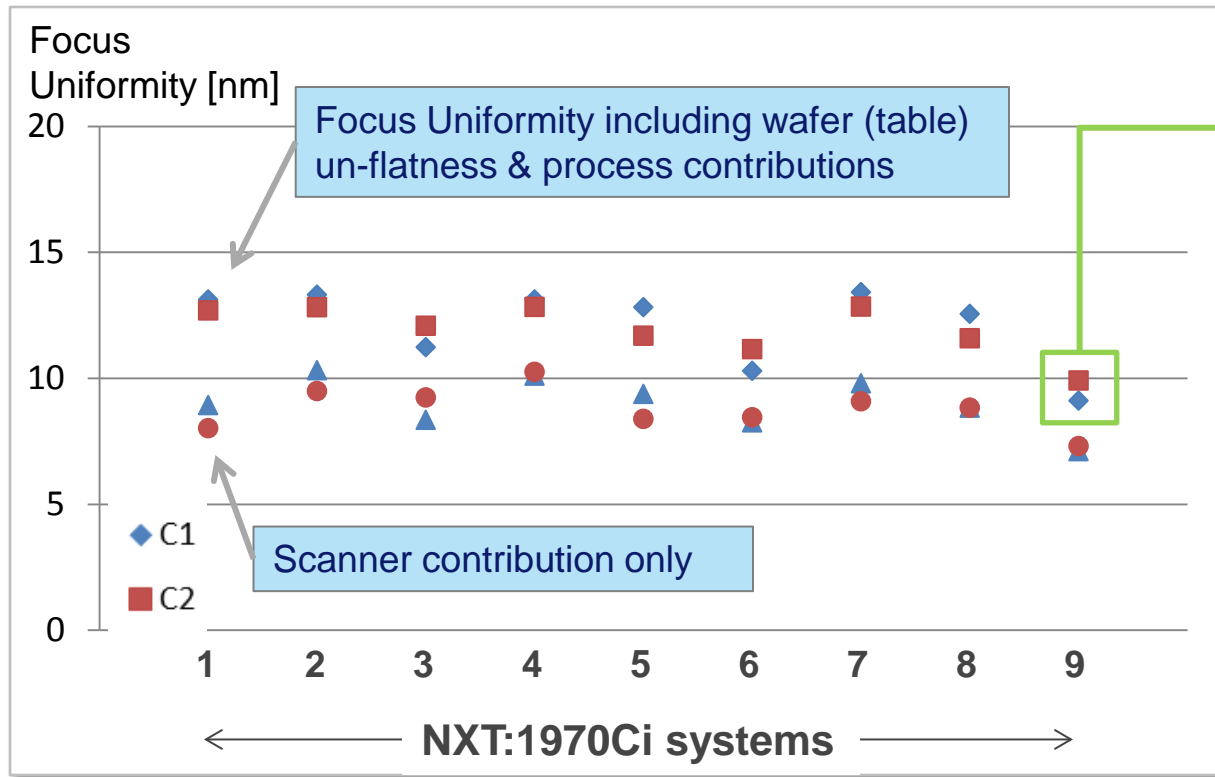


Focus



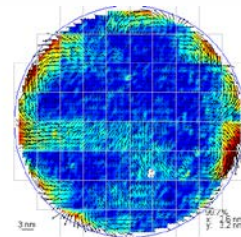
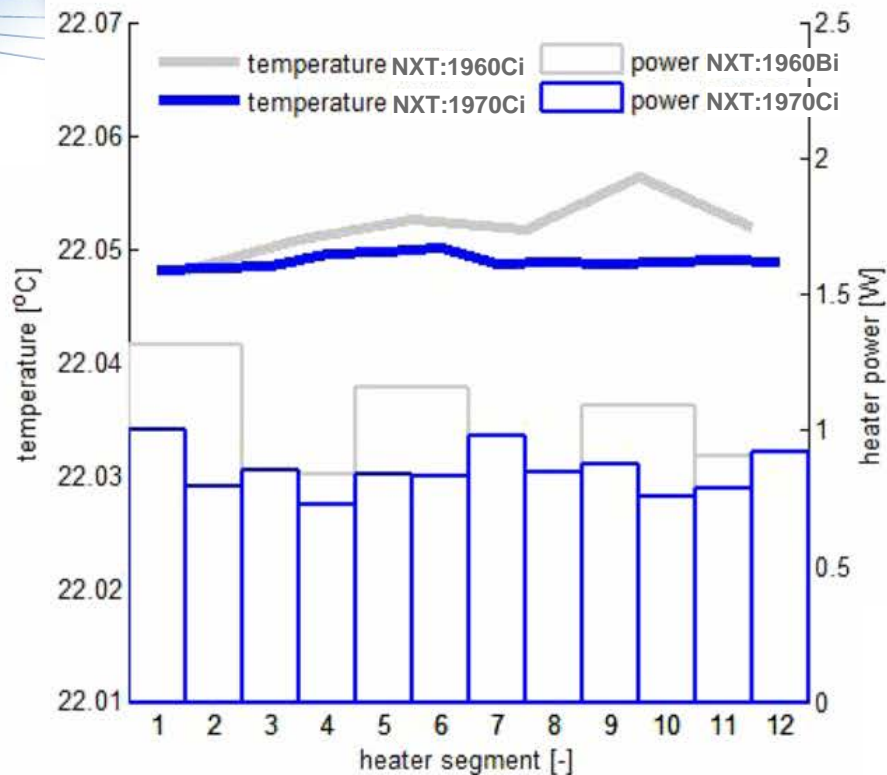
NXT:1970Ci shows down to 10nm focus uniformity

consistent for all systems & center-to-edge

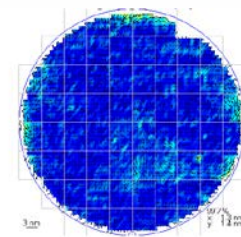
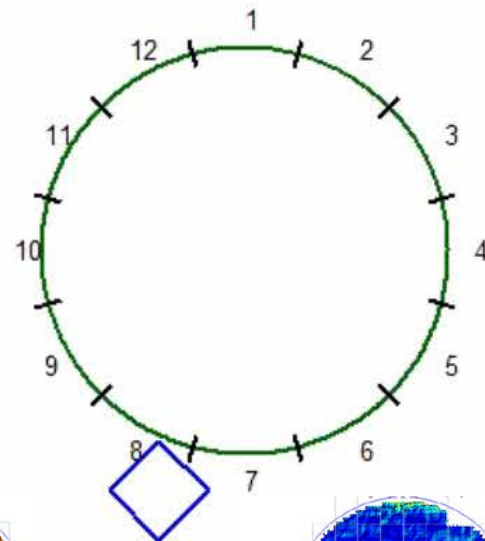


Results have been corrected for Offset & tilt per field to illustrate Imaging Optimizer capability

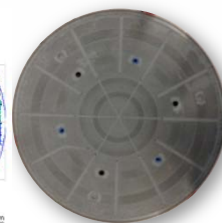
NXT:1970Ci wafer table heater minimizes fingerprints



NXT:1960Ci segmented wafer table heater



NXY:1970Ci multi-segment wafer table heater



TWINSCAN NXT:1970Ci design improvements

to support down to 1x nm node requirements

Wafer Stage:

*Higher throughput
Tighter focus & overlay
Improved thermal stability*

Lens:

*Reduced non-correctable errors
Improved Matching*

Immersion hood:

Higher productivity

UV Level sensor:

*Process independent leveling
Improved edge focus control*

Parallel lens interferometer:

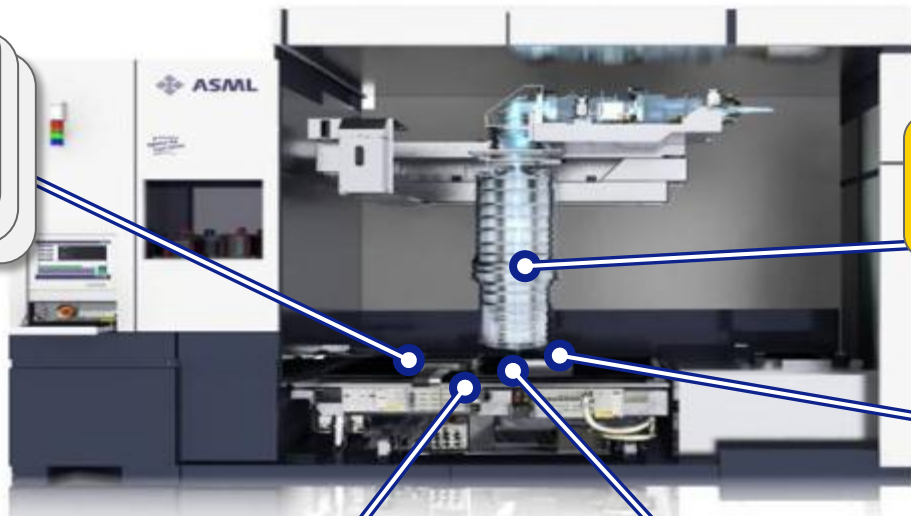
*Improved Lens heating &
Reticle heating control*

Legend:

Overlay

Imaging/Focus

Productivity



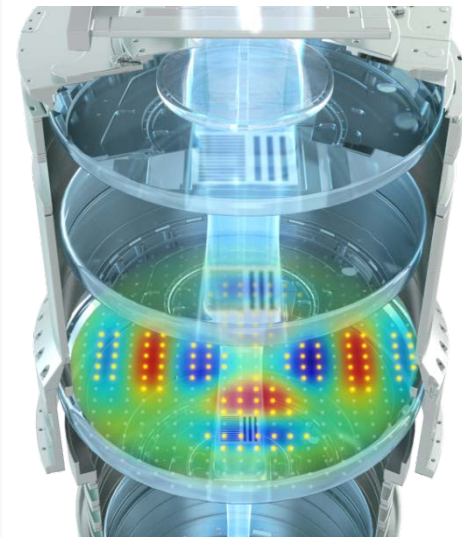
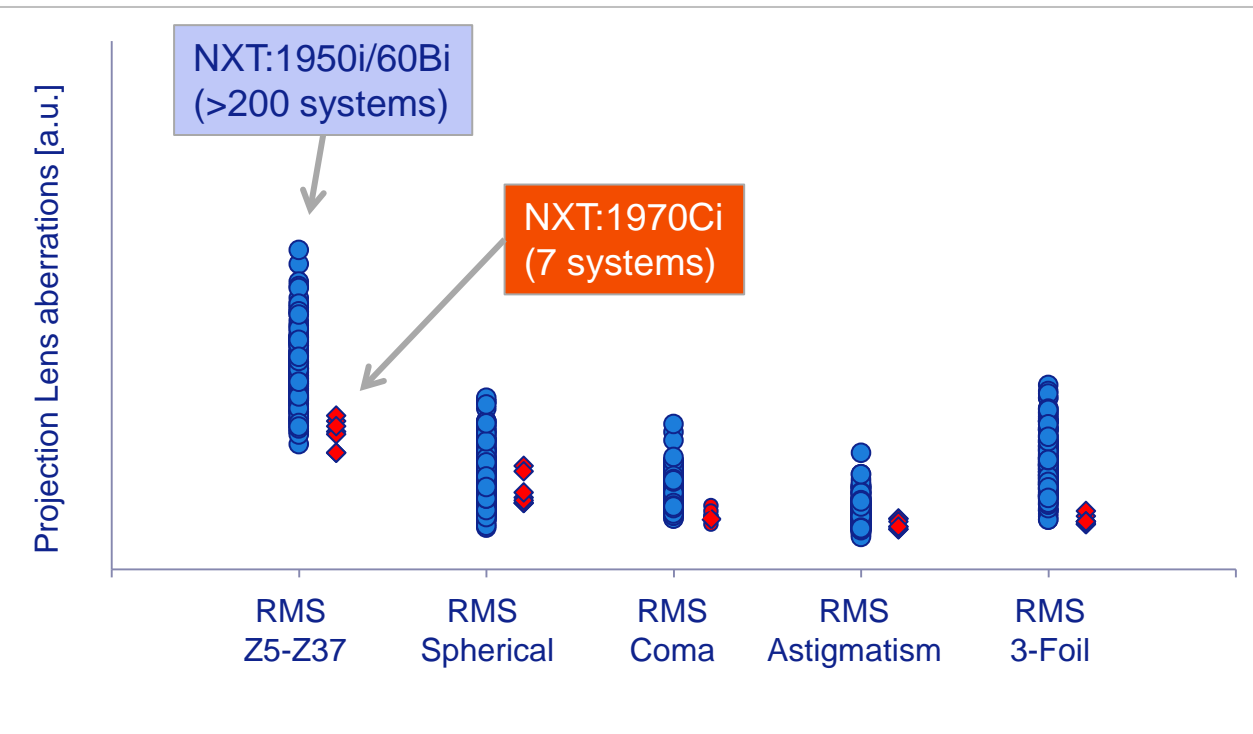
Improved NXT:1970Ci projection lens aberration control

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Public

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5 March 2014



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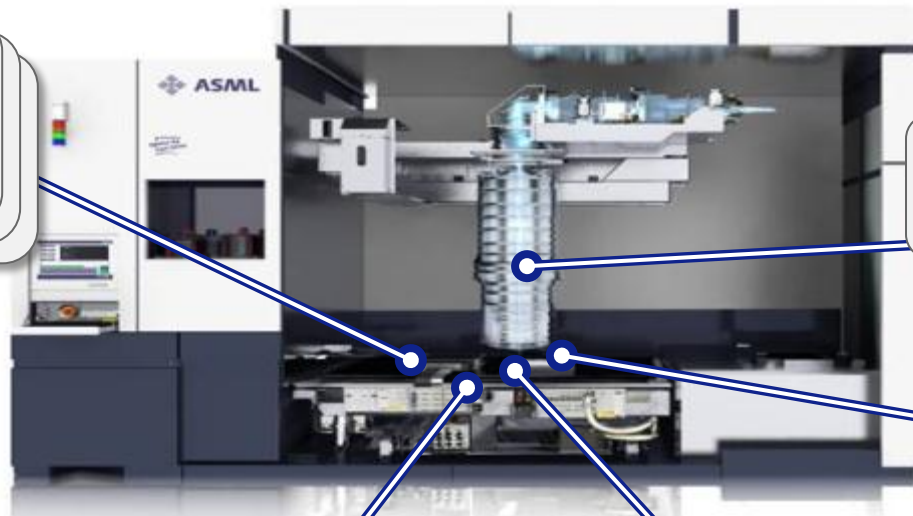
*Improved Lens heating &
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Legend:

Overlay

Imaging/Focus

Productivity



Parallel Image sensor enables minimized reticle heating

ASML

Public

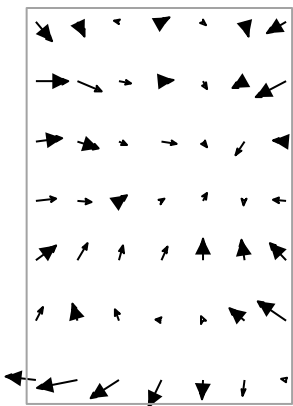
Slide 16

5 March 2014

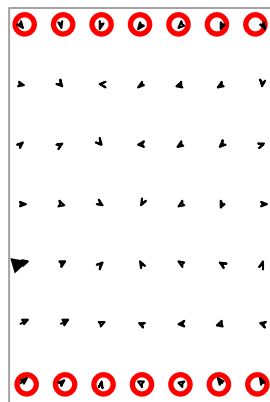
PARIS sensor allows for accurate higher order corrections

NXT:1960Bi

NXT:1970Ci with
PARIS sensor

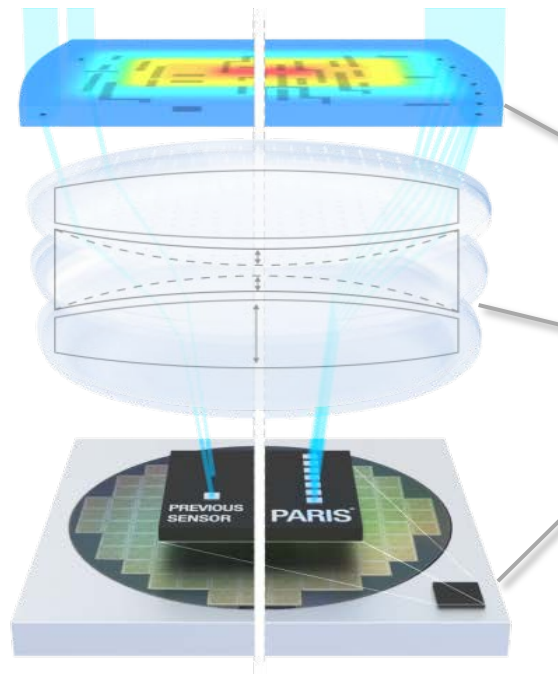


1 nm
→



1 nm
→

*Reticle heating residuals after correction
(max over 15 wafers, 50 mJ/cm²)*



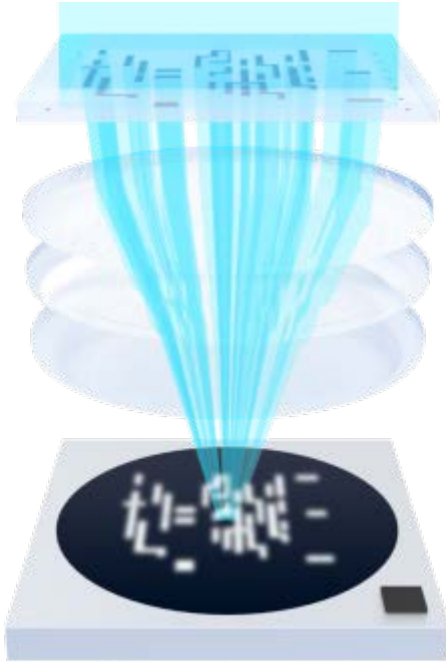
2x7 points capture actual
barrel shape

Lens correction using
scanning lens element

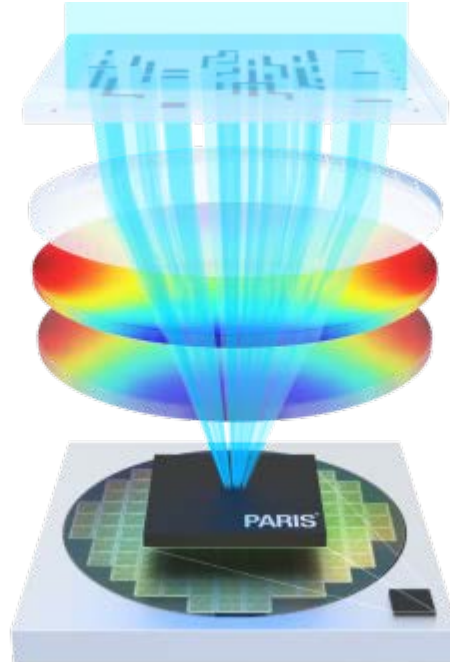
Faster & more accurate
measurement using Parallel
Lens Interferometer (PARIS)

Automatic wafer-by-wafer lens heating corrections

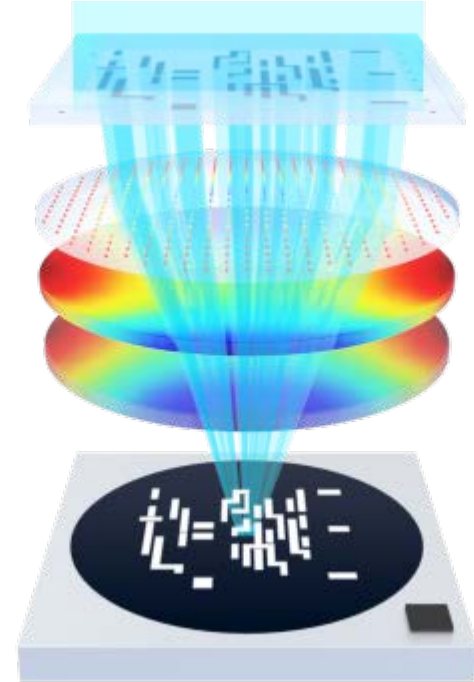
New ultra-fast Paris sensor measures lens heating in between every wafer



Lens heating causes field distortion offsets



New multifunctional sensor detects lens heating ...

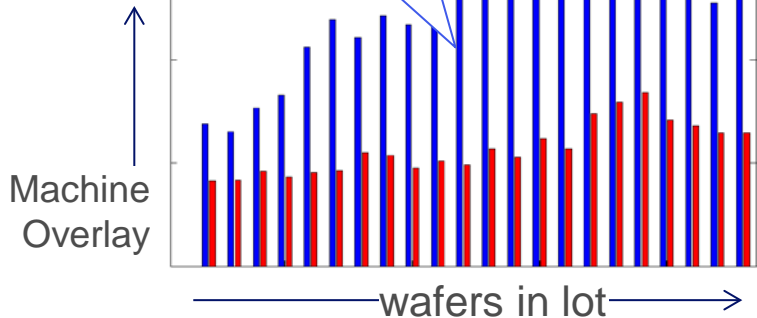


And corrects it with aberration manipulator

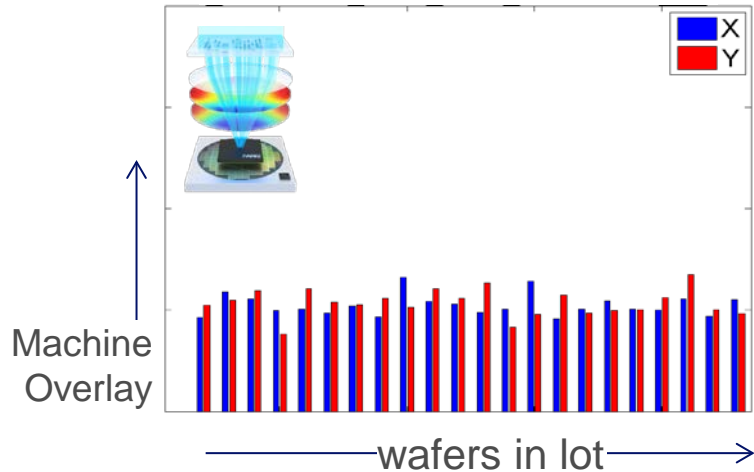
NXT:1970Ci lens heating corrections result in stable through-lot overlay

Lot-by-lot feed forward correction only

Overlay drift mainly due to low order aberration drift (Z2/3)



Wafer-by-wafer feed back correction with Paris sensor



1st layer: Annular illumination | low reticle transmission
2nd layer: Dipole illumination | high reticle transmission

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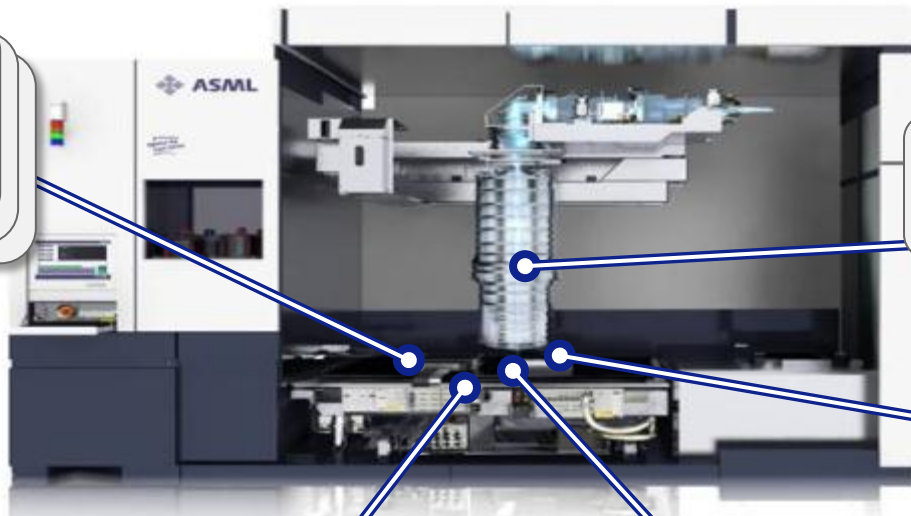
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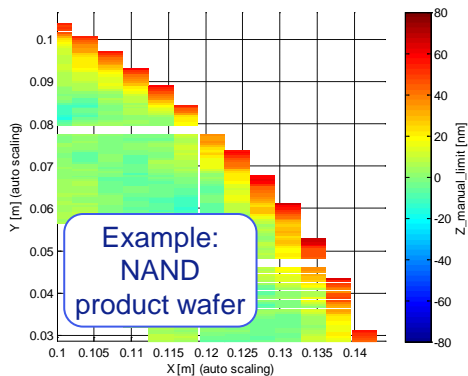
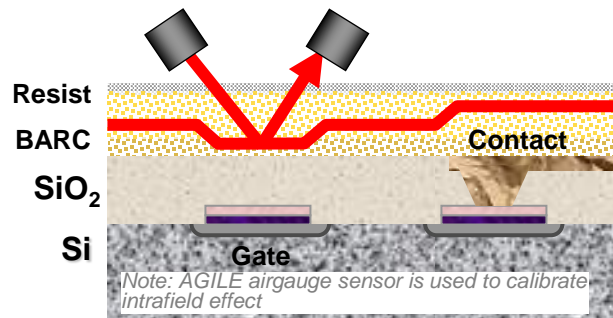


Reduced process dependency by leveling with UV LS

More and smaller detection spots for more accurate edge measurement

Previous level sensor

600 nm ~ 1 μ m

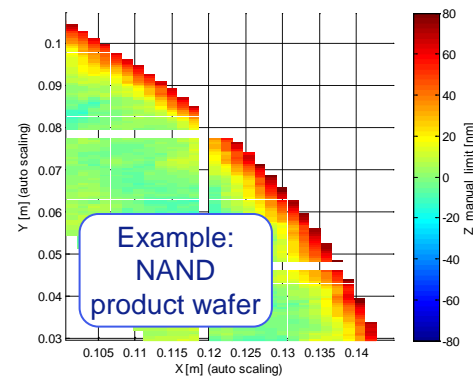
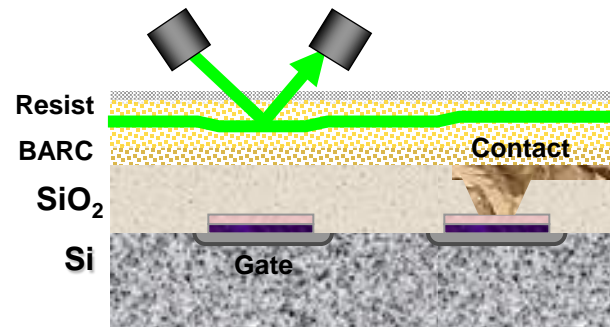


Reduced process
& product
sensitivity

accurate edge
roll-off
measurement

New level sensor (UV-LS)

200 nm ~ 425 nm



NXT:1970Ci UV Level Sensor works for all applications

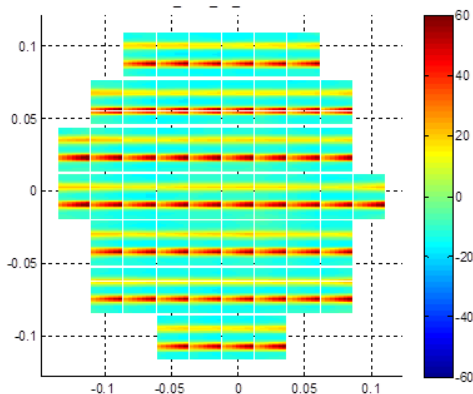
ASML

Public

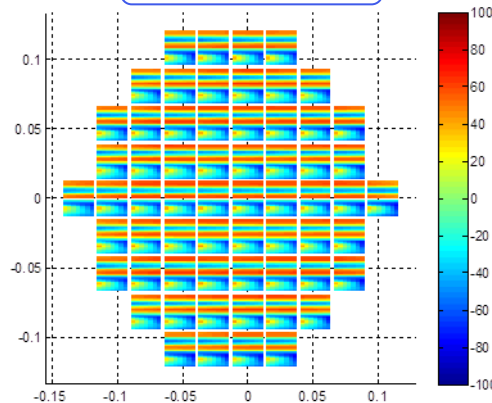
Slide 21

5 March 2014

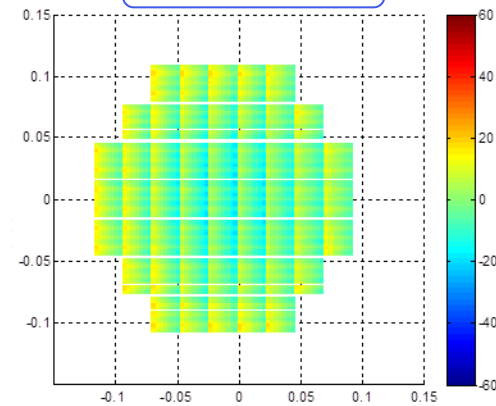
LOGIC



DRAM

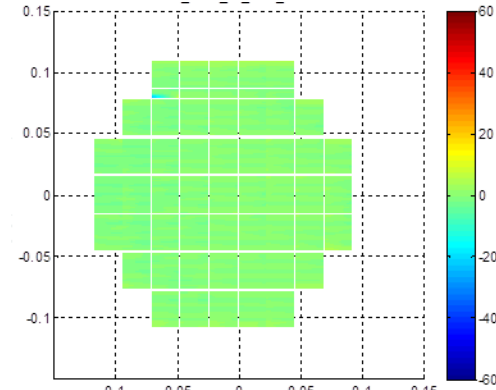
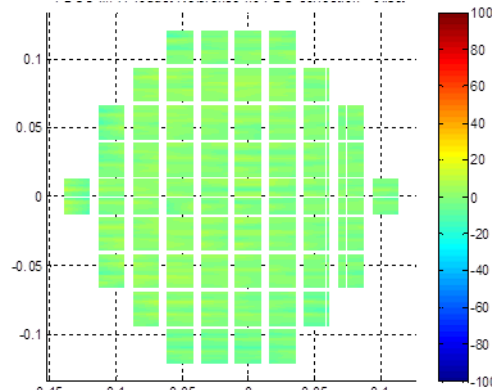
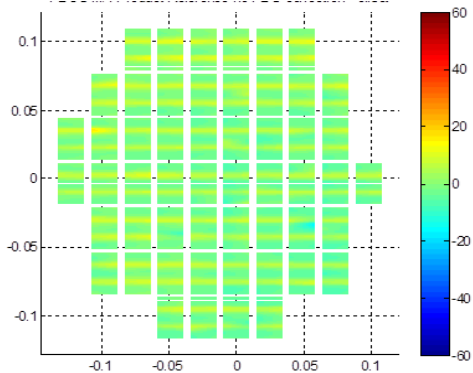


NAND



previous
Level Sensor
600 nm
~
1 μm

UV
Level Sensor
200 nm
~
425 nm



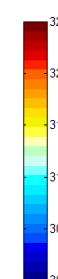
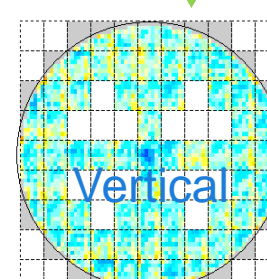
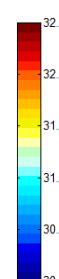
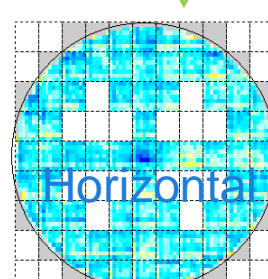
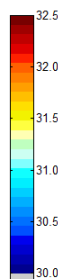
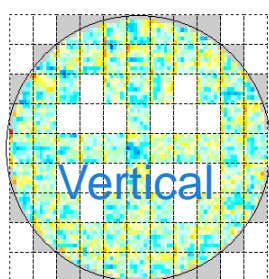
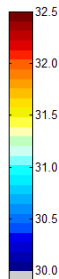
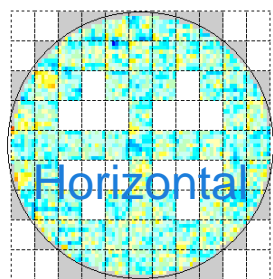
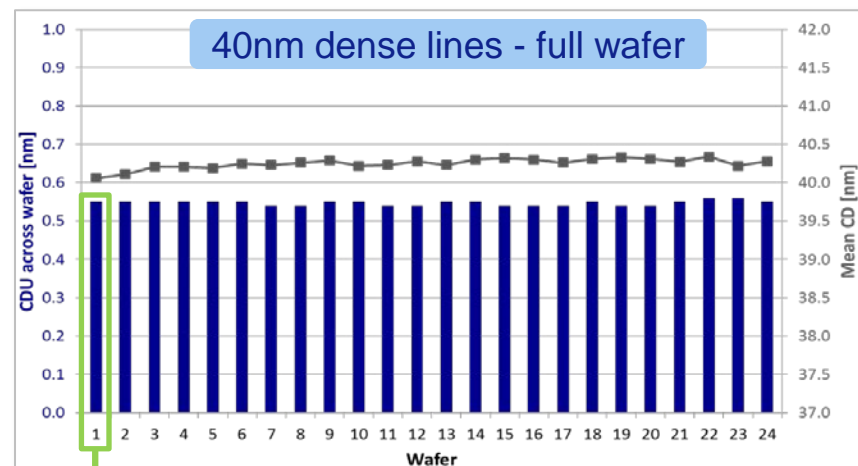
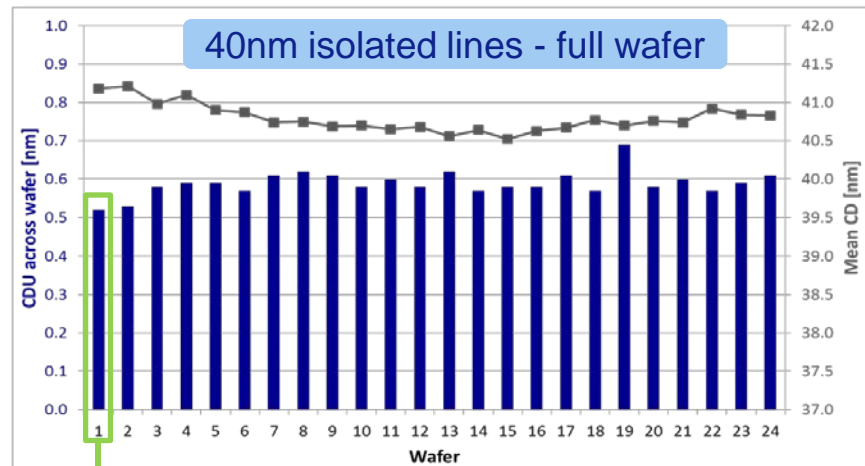
No air gauge sensor
based intra-field
fingerprint
compensation applied



ASML

NXT:1970Ci system
Imaging performance

NXT:1970Ci shows stable CDU through lot





ASML

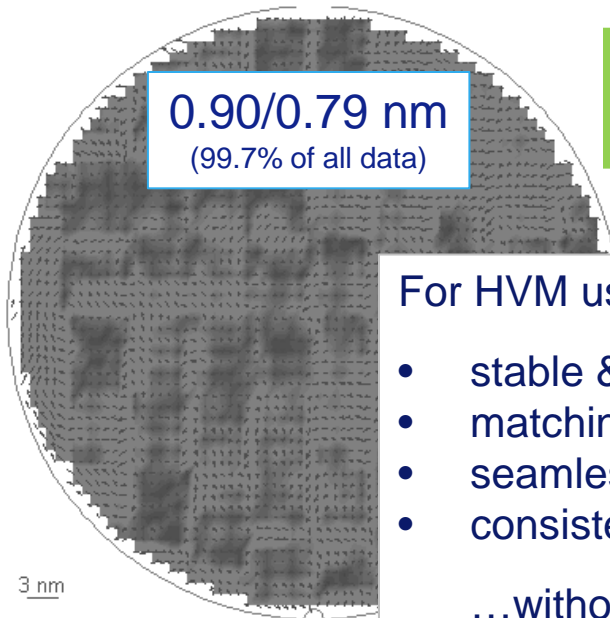


NXT:1970Ci system
Overlay performance

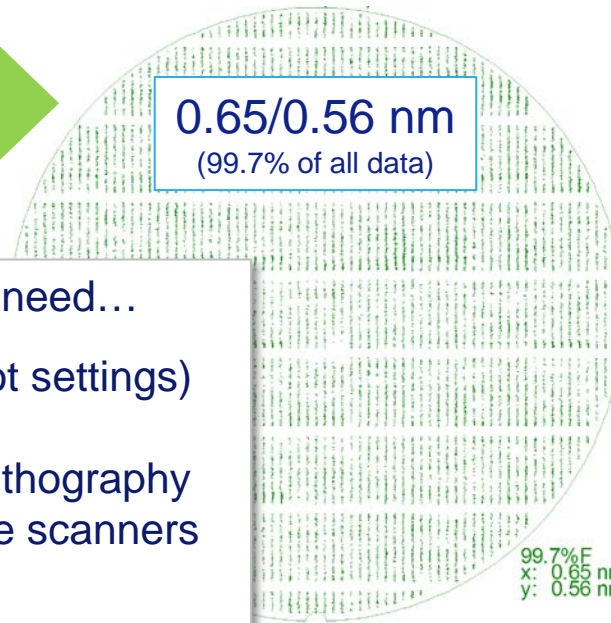
NXT:1970Ci design shows improved machine overlay to well below 1 nm

NXT:1960Bi at 230 WpH & 700mm/s
(SPIE 2013)

NXT:1970Ci at 250WpH & 800mm/s
(2014)



>25%
overlay improvement



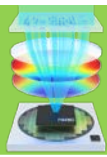
For HVM usability chip manufacturers need...

- stable & robust overlay (heating, lot settings)
- matching to ArFi & EUV
- seamless integration with holistic lithography
- consistent performance for multiple scanners

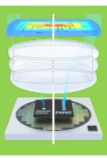
...without productivity compromise

NXT:1970Ci minimizes heating and lot transition effects


resulting in <2 nm machine overlay through lot



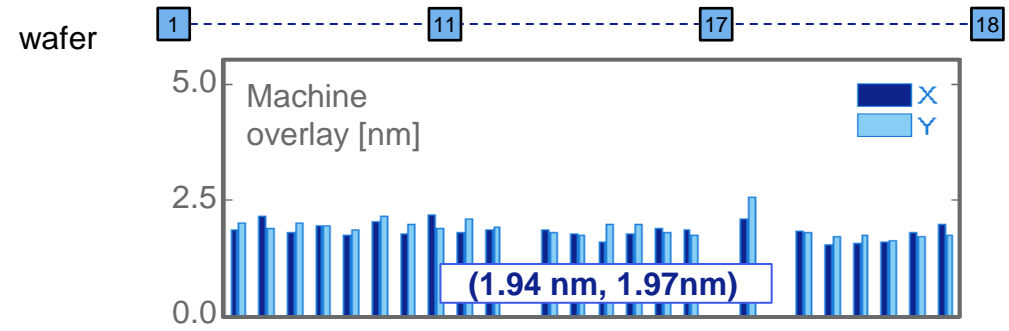
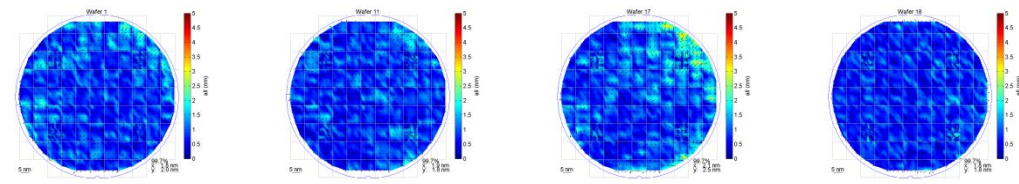
Paris in-line lens heating correction



Paris in-line reticle heating correction



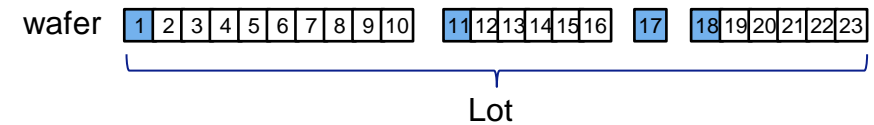
Multi-segment wafer table heating correction



1st Layer

Reticle heating
Lens heating

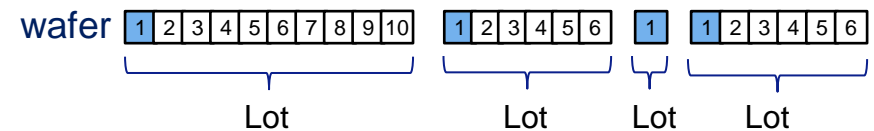
Dense Lines
Mode = Quasar
NA = 1.35, Sigma = 0.98/0.90
Transmission: ~40%



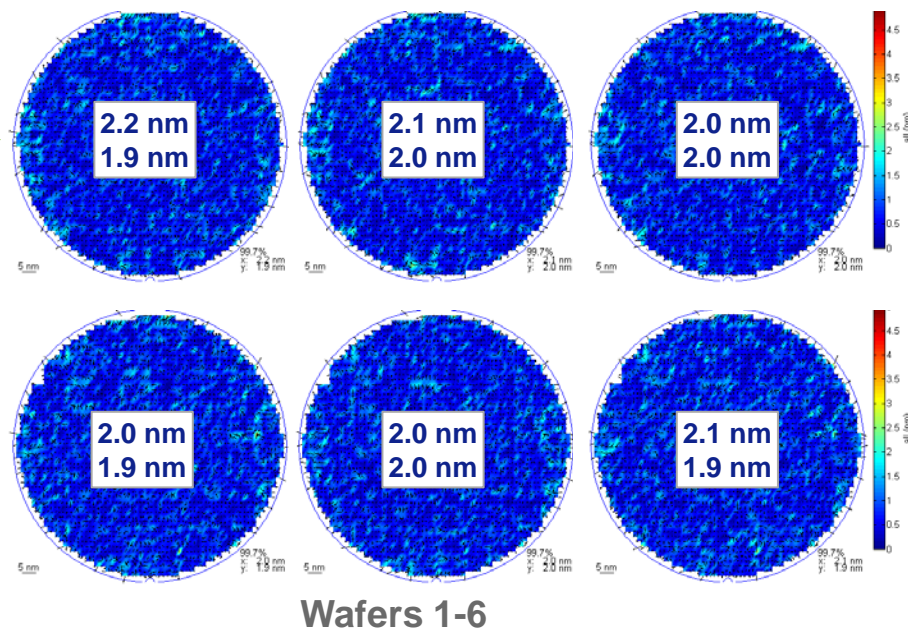
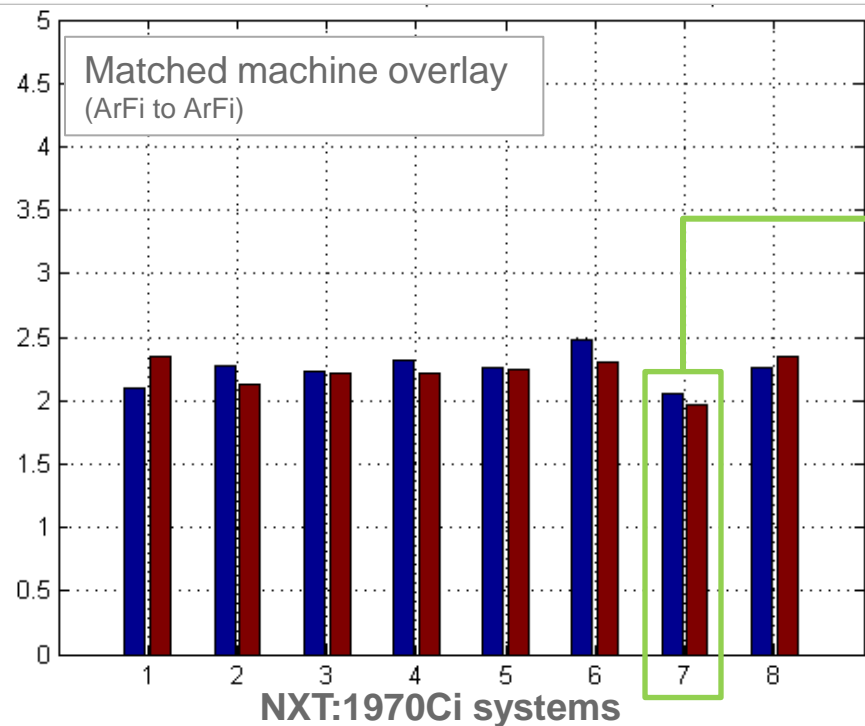
2nd Layer

Wafer heating
Varying lot sizes

Cuts/Via's
Mode = Annular
NA = 1.35, Sigma = 0.94/0.79
Transmission: ~80%



NXT:1970Ci shows <2.5 nm matched overlay capability consistently for all systems



NXT:1970Ci ArFi supports EUV insertion overlay matching at 2.6nm demonstrated

Matched Overlay EUV to ArFi

X: 2.6 nm Y: 2.5 nm

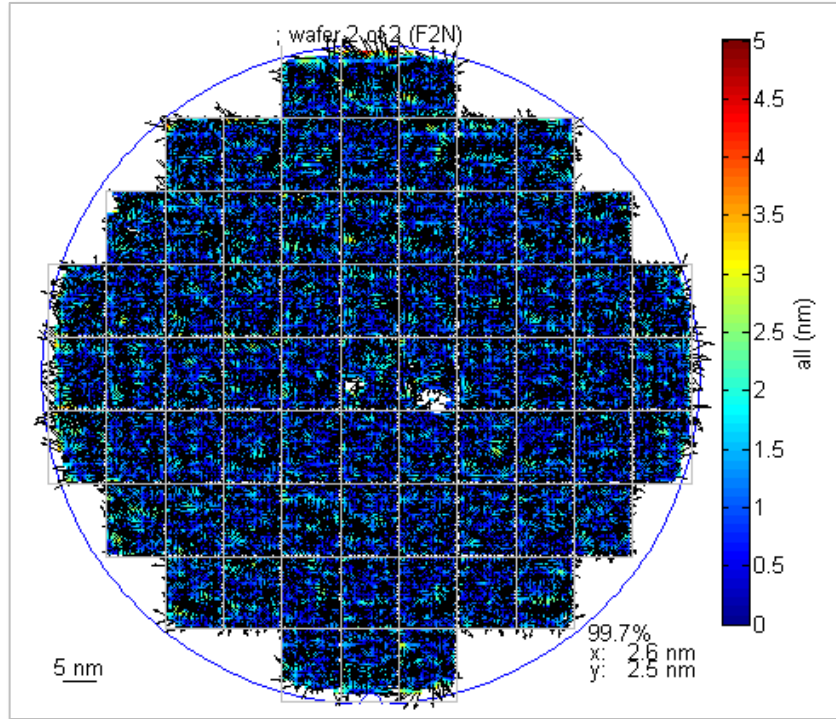
1st layer

NXE:3300



2nd layer

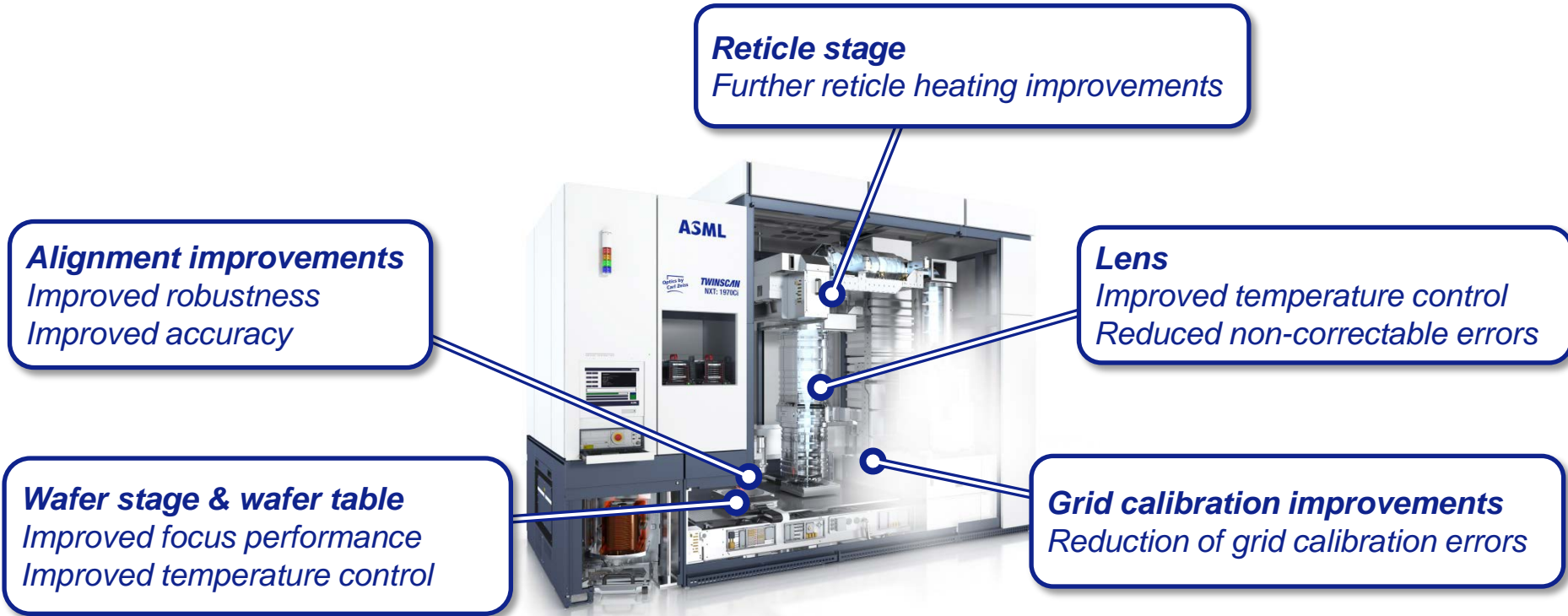
NXT:1970Ci



Future developments

Future improvements will be driven by Overlay & Focus control

Several improvement areas under investigation



Summary

TWINSCAN NXT ArFi supports overlay & focus requirements for 1x nm nodes at high productivity

- NXT:1960Bi systems at chipmakers show up to **> 5000 WpD productivity**
- New NXT:1970Ci ramping to HVM productivity
 - **250 WpH wafer throughput** at 800mm/s with robust immersion defect control
 - **New parallel image sensor** minimizes lens & reticle heating effects
 - Reduced process effects & accurate edge detection by **UV Level Sensor**
 - Intrinsic **machine overlay as low as 0.65nm**
 - **Matched overlay to ArFi capability <2.5 nm** shown on all systems
 - Overlay **matching to EUV at 2.6nm** demonstrated



Acknowledgements to:

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